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TYPICAL PROBLEMS IN THE DEVELOPMENT OF MODERN POWER SUPPLY IN LESS DEVELOPED AREAS

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TYPICAL PROBLEMS IN THE DEVELOPMENT OF MODERN POWER SUPPLY IN LESS DEVELOPED AREAS

by

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(1) It is the purpose of this paper to describe, in terms of some specific areas concerning which the writer has personal and professional knowledge, the situation of electric power supply before and after major development efforts. In each case a new institution was established which undertook to expedite a process of change as one of its major functions. Of these institutions, each has a framework of major characteristics which is of interest. The specific problems with which these new agencies dealt are set forth, and the actual solutions that were adopted are stated. The present status of power supply and prospects for the future are also summarized.

(2) The cases include the areas served by the Tennessee Valley Authority (TVA); Greece, which is served by the Public Power Corporation (PPC); El Salvador, where increments of power supply are the responsibility of the Comision Ejecutiva Hidroelectrica del Rio Lempa (CEL); Puerto Rico, served by the Puerto Rico Water Resources Authority (PRWRA); and the Khuzestan region of Iran, where a modern power system is under development by the Khuzestan Water and Power Authority (KWPA).

(3) The final portion of the paper summarizes some conclusions, based upon the experience in these five areas, which are of potential significance in other areas facing somewhat similar problems in providing modern power supply for their homes, farms, commercial establishments and factories. Especially to be noted are the common elements in the individual solutions developed in each of the areas. These common elements may well be significant for other areas because they can be clearly identified in the five cases, and because in all five, modern electric power supply has been or is being achieved in areas where electric service had previously not met modern standards of adequacy, reliability, and reasonableness of cost.

THE CASES

The TVA Area

(4) In 1933, during the early days of the administration of President Roosevelt, the law was passed which established the Tennessee Valley Authority. The TVA Act was the conclusion of a series of preceding but unsuccessful efforts to establish an agency for development of the resources of the Tennessee River and the region through which it flows. Key policies for electric power included:

(a) The TVA power system was to be self-supporting and self-liquidating. It was to be able to use its revenues for power system purposes.

(b) Power was to bear its share of the costs of facilities used also for TVA's primary purposes of flood control and navigation.

(c) TVA power was to be conceived as being available primarily for the benefit of the people of the section as a whole with preference for the domestic and rural consumers, and the sale of power to industry was to be a secondary purpose, primarily to secure a high system load factor and to improve revenue returns. TVA was to seek the application of electric power to the fuller and better balanced development of the resources of the region.

(d) The Act clearly implied that TVA was to sell power primarily on a wholesale basis, giving preference to public and cooperative agencies not doing business for a profit.

(e) In lieu of taxation, TVA was to pay a percentage of its revenues from the sale of power to the states within which it operates, a part of these payments to be paid to local agencies of government which suffered loss of tax revenues due to TVA's acquisition of properties formerly in private ownership. This percentage is now 5%.

(5) Some of TVA's other key policies applying to all of its operations included:

(a) It was to have much of the flexibility of a private enterprise. For example, its employees were to be appointed without any political tests and were to be employed under a merit system with salary classification established by TVA, independent of the U.S. Civil Service system.

(b) Its Board was to consist of three members, chosen by the President with the consent of the Senate, responsible to the President and with staggered terms, ultimately nine years each to assure continuity through changes in national administrations.

(c) Its accounts were to be kept in accordance with the Federal Power Commission system of accounts.

(d) It was given the power of eminent domain.

(e) It was to have authority to take necessary action to carry out these policies.

(6) By 1933, in the Tennessee Valley region power supply was, in most cases, available from large central station sources only in the major centers of population. There were a number of isolated municipal systems, usually depending on diesel-electric generators. Rural electrification extended to only 3% of the farms. Average residential use was 600 kwh per year, about the same as the national average. Total regional electrical energy requirements were about 1-1/2 billion kwh. In hearings about TVA legislation and appropriations, representatives of existing power systems testified that the future market for power in the region was limited and the capacity planned for installation by TVA was not required.

(7) One of TVA's statutory tasks was to develop a comprehensive plan for integrated development of the Tennessee River and its tributaries. This was completed in 1936, and guided future development.

(8) TVA, located in an area which was predominantly agricultural, began its operations with a labor force in which modern industrial skills were limited. Training of foremen, accountants, managers and skilled workers was an essential element of its early program.

(9) In order to develop the region's power supply on the most economical basis, an integrated generation, transmission and distribution system was required. This was accomplished largely through the acquisition by TVA of the existing bulk supply (generation and transmission) facilities, and through acquisition of the existing distribution facilities by local public agencies, and by cooperatives, which became the distributors of TVA power. Acquisitions were negotiated at prices agreed upon between buyers and sellers. The acquisition program was completed in 1945 and included properties for which sales prices totalled about $125 million. The facilities thus acquired were interconnected with newly constructed facilities owned by TVA and by the municipal and cooperative distributors of TVA power.

(10) TVA's financing has come primarily from direct Congressional appropriations and from its own earnings. The early acquisition program was financed in part by the issuance of bonds which were purchased by the U. S. Treasury. Within the past few years, TVA has been authorized, by amendment of the Act, to issue up to $750. million

in revenue bonds for sale to the public to finance the further expansion of its power system within its existing service area. Some $100 million of such bonds have since been issued.

(11) TVA now supplies power throughout an area of some 80,000 square miles, with a population of some 5 million and with about 1-1/2 million consumers of electricity. Total requirements for electrical energy have reached 60 billion kwh, or about 40 times their level of 30 years ago. Almost half of these requirements are for national defense purposes, including atomic energy. Ninety-eight percent of the farms in the region have electric service. A high proportion of all new homes are heated with electricity. Average residential consumption is almost 10,000 kwh per consumer per year, or about 2-1/2 times the national average. The average rate for this service in the TVA area is a little less than one cent per kwh, or about 40% of the national average. With total system generating capacity of over 12 million kw, TVA ranks as one of the largest integrated power systems in the world. Having practically exhausted the economical hydroelectric power in its region, it will, in the future, depend largely upon thermal sources to meet its continued growth requirements. It now uses about 20 million tons of coal per year. TVA has a cooperative understanding with the Atomic Energy Commission for work on an experimental gas-cooled reactor for power purposes.

Greece

(12) When fighting ceased in Greece in 1949, it was recognized that electric power supply should have a high priority in the work of reconstruction and expansion which needed to be done. A survey of power requirements and some of the principal power resources was made by a firm of consulting engineers financed by U.S. aid funds. Following the completion of this survey, the U.S. and Greek Governments agreed that electric power development would be one of the major programs during the period of reconstruction, to be financed in part by Marshall Plan funds, in part by Italian reparations, and in part by Greed resources.

(13) In 1950, the Greek Parliament enacted legislation to establish the PPC to own and operate the new power system, a private company being engaged to manage the affairs of the PPC, to train its personnel, and to supervise the contractors engaged in developing the new power facilities.

(14) Before PPC came into being, the only modern electric system in Greece, with electricity in reasonably adequate supply at reasonable cost, was that belonging to the Athens-Piraeus Electricity Company (APECO), largely owned by British interests, and serving the metropolitan area of the capital. In the second city of Greece, Salonika, the urban electric system was partly alternating and partly direct current, and service was inadequate and costly. In 1950, a portion of that city's power supply came from small naval vessels moored at the quay and connected to the electric distribution system. Salonika's entire system had to be extensively rebuilt and expanded. A few other urban centers had electric service but only on an inadequate and high-cost basis.

(15) By 1954-55, PPC completed the first stage of a new nationwide system which included three hydroelectric plants, a large thermal-electric station, a 150 kv transmission system, and primary distribution networks at 15 kv. Service began to be extended to the villages of Greece. Inadequate urban systems were replaced. Further power expansion was undertaken by PPC after the completion of the first program. In 1960, PPC acquired the APECO system. Today, PPC is responsible for power supply throughout Greece, including the Greek islands. Only a few local systems remain in their previous ownership, the largest being that of Patras.

(16) In 1950, total generating capacity in Greece was less than 200,000 kw. By 1955, with the completion of the initial expansion program financed in part by U. S. aid, total capacity had doubled. The second expansion program now completed or under construction will bring the total generating capacity to about a million kw, or over

five times the capacity in 1950. Further substantial expansion of the PPC system is now under design. Since 1955, development has been largely financed by earnings and by internal and external loans and equipment credits.

(17) PPC's initial policies were set forth in its original enabling legislation, adopted in 1950, and in its subsequent amendments. It was to be an autonomous agency, responsible to the Greek State through the Ministry of Industry. Members of the Board of Directors were to be appointed by the Government on the Minister's recommendation. The members of the seven- (later changed to nine-) man Board were to have five-year terms of office, for staggered periods. Power was to be supplied by PPC on a basis which would assure its availability at the cheapest possible cost to the consumer, while PPC covered its costs of service. There was to be no unreasonable discrimination in the sale of power between regions of the country or between customers of the same class. For its key personnel, PPC was to be exempt from Civil Service rules and regulations. It was to be able to act as though it were a commercial enterprise. Its accounts were to be kept in accordance with best modern public utility accounting practice. There was to be a Representative Assembly, consisting of representatives of government, labor, banks, industry, the principal municipalities, professional societies and trade associations, etc., with responsibility for general annual or special review of PPC's operations.

(18) It was intended that the resources used by PPC for power supply were to consist primarily of those indigenous to Greece, water power and lignite. Before 1950, except for emergency use in war-time, these resources were practically undeveloped. PPC has been instrumental since that time in opening up a large lignite deposit at Aliveri, on the island of Euboea, to fuel a power plant at that location, and a very large deposit at Ptolemais in the north, to fuel another power plant and to provide raw material for industrial development. A 150 kv interconnection has been established with Yugoslavia.

(19) Most of the villages on the mainland of Greece and many on the islands have been electrified under the PPC program. A standard set of rate schedules are applied throughout the PPC service area, including the islands, except in the capital region, where APECO's rate structure has been maintained by PPC, the new owner. The levels of average rates for the various classes of consumers are not significantly different in these two parts of the PPC territory.

(20) PPC's rate of growth has averaged 10 to 12% per year, the growth being more rapid outside than inside the capital area. Total use of electrical energy was 538 million kwh in 1950, of which 451 million kwh were used in the Athens-Piraeus area. Total use in 1961 was 2156 million kwh, of which 1445 million were used in the capital area. Plans for new power sources are under active consideration to meet future needs including the provision of a new large thermal power station in the Peloponnesus at Megalopolis, which will tap large lignite deposits in that area.

(21) The hydroelectric development of the Acheloos River in Western Greece, which is to be interconnected with the national network, is the base for quite an industrial complex, including an aluminum smelter being erected by a combination of French and American interests.

(22) Since 1955, PPC has been managed and operated by its Greek organization. The Ebasco management group was entirely withdrawn after expiration of its original five-year contract, and consulting services have since been of a more technical and traditional character.

El Salvador

(23) El Salvador, a Central American republic, has a population of about 2-1/2 million, and an area of some 8,000 square miles.

(24) In 1945-46, it was decided by the Government that a large increment of electric power was needed, and a hydroelectric development at Chorrera del Guayabo, on the Lempa River, with associated transmission facilities, was undertaken, after detailed

investigations. In 1948, the IBRD undertook the financing of the foreign exchange portion of the costs of this project. The consulting engineers were responsible for design and supervision of the construction of the project. The dam is now known as the Fifth of November.

(25) Before 1948, the only fairly large electric system was that in the capital, San Salvador,(CAESS), which also served the surrounding towns. It is owned by a Canadian group. The same group owns the much smaller system serving San Miguel, in the eastern portion of the country. Another smaller system served Santa Ana in the west, and there were small scattered systems in other towns, most of them privately-owned. In 1953, total generating capacity in the country was about 20,000 kw.

(26) With the decision to move ahead with the Lempa development, the Government of El Salvador established, through legislation and executive action, CEL, a public entity owned by the Government. Initially established by decree to make the necessary preliminary studies and investigations, CEL was later (1948) given a legislative charter. CEL had a seven-man board of directors with staggered four-year terms, four of whom were designated as individuals by the Government (acting through four cabinet offices) and of the other three, one was selected by the banks, one from a list provided jointly by the local agricultural, commercial and industrial associations, and one by the local bondholders (other than the Government). For each board member, an alternate was appointed by the same procedure.

(27) The Lempa project includes four generating units of 15,000 kw each, two of which were installed by 1954, one in 1957, and the fourth in 1961. A second hydro project, Guajoyo, is almost completed. It will control and utilize the outflow from Lake Guija, which lies athwart the border of El Salvador and Guatemala.

(28) CEL's legislative charter gives it irrigation as well as power responsibilities. It is exempt from civil service rules and regulations. It is to operate as an autonomous non-profit public service enterprise. It is directed to give preference to the sale of power at wholesale to public or private agencies. Rates and charges are to be reasonable and adequate to cover costs, including debt service. CEL can borrow money in its own name, with Government approval. It has the right of eminent domain. Employees are to be chosen solely on the basis of merit and efficiency, without any political test. CEL and its contractors are exempt from customs duties, for imports necessary for its work, and from local taxation.

(29) In 1953-54, CEL negotiated a wholesale power contract with CAESS, which specified wholesale and retail rates, and the maximum rate of return on investment which the company was to be permitted. This contract gives CEL the opportunity to assure that the benefits from the availability of CEL power are shared on a reasonable basis between the consumers and the owners of the company. Since return has recently exceeded the contractual allowance, retail rates were reduced in 1961.

(30) Since 1953, the year before the Fifth of November project began operating, generating capacity in El Salvador has been quadrupled and requirements have risen equally rapidly. CEL now supplies over four-fifths of the country's electrical energy needs. Over 80,000 consumers are using CEL power. Service has been extended to most of the main urban centers from the CEL system, and contracts similar to that with CAESS have been negotiated with the distributors in other areas.

Puerto Rico

(31) Puerto Rico, an island about a thousand miles south and east of Miami, Florida, bounded by the Atlantic and the Caribbean, has an area of about 3500 square miles. Its population is approaching 2,500,000. It is a Commonwealth within the United States, with a unique constitution established in 1952 by compact.

(32) In 1942, legislation was enacted by the Puerto Rican territorial legislature establishing the PRWRA, an entity owned by the people of Puerto Rico. Its purposes were to produce and supply electricity, which it now does throughout the island, being responsible for serving all but a few of the ultimate consumers. It also had some irrigation responsibilities.

(33) In 1942, PRWRA acquired the properties of the Canadian-owned company serving the San Juan capital area, and of the company serving the third largest urban center, Mayaguez. The privately-owned system serving Ponce, the second largest town, had been acquired previously by the public agency which was the predecessor of PRWRA.

(34) In 1941, the year before PRWRA was established, the total production of electrical energy for public use in Puerto Rico was about 192 million kwh; and 113,000 consumers were being served. Twenty years later, in 1961, total production was about 2,300,000,000 kwh, or a multiplication in two decades by twelve times. In 1961, over 400,000 consumers received service.

(35) The legislative charter of PRWRA provided for the establishment of a three-man Board of Directors, the members to serve ex-officio, including the Governor, who was the Chairman of the Board, and two members of his cabinet. Responsibility for managing the affairs of the agency was placed in the Executive Director, who was to be chosen by the Board. The PRWRA Act provides that charges for electric service fixed by PRWRA shall be reasonable and adequate to cover costs, including obligations to the holders of the agency's bonds. It may borrow money in its own name and pledge its revenues for its debt service. It appoints its own officers and employees and fixes their rates of compensation. It has the power of eminent domain, in the name of the people of Puerto Rico. In lieu of all other taxes, PRWRA pays 5% of its power revenues to the Commonwealth Treasury, and 6% is divided among the municipalities within which it operates.

(36) The PRWRA system was in part acquired from its predecessor public agency (which was called Utilization of Water Resources, an office of the Insular Government), in part built with grants from the United States, and in part acquired or constructed with funds obtained through the sale of revenue bonds on the New York market. The most recent bond sale, in 1962, was in the amount of $22,000,000., at an average annual interest rate of about 3.6%.

(37) About 110,000 kw of PRWRA's generating capacity is hydro-electric. Since practically all of the economical hydro sites have been utilized, increments since 1956 have been thermal-electric. The thermal plants are fueled with oil, largely consisting of the heavy residuals available from the two oil refineries now in operation on the island, one in the north and one in the south. Total PRWRA generating capacity at June 30, 1962 was about 700,000 kw.

(38) The expansion of rural electrification throughout the rather mountainous terrain has been rapid. The work is carried out under a program financed by the Rural Electrification Administration of the U. S. Department of Agriculture which buys some of PRWRA's bonds each year, with an annual interest cost of 2%. Rural electrification is also supported by annual payment from the Commonwealth Treasury, in order to enhance its economic feasibility for PRWRA.

(39) PRWRA is staffed almost 100% by Puerto Ricans. Many have had training in the continental U.S. Consulting engineers were retained for consultation and advice, especially in the fields of power economics and management policy. PRWRA, in cooperation with the U.S. Atomic Energy Commission, is constructing a 16,000 kw nuclear power plant (BONUS) in the western portion of the island. This plant will have the advanced feature of integral nuclear superheat with a boiling water reactor.

(40) Puerto Rico has for the past ten years been engaged in what has become known as Operation Bootstrap, an intensive program of economic development. As a result, several hundred new industrial enterprises have been established on the island, transportation and communication have been improved, modern water supply and sewerage systems have been built and the standard of living has been significantly raised. Income from industrial activity now exceeds by a significant margin agricultural income, which had been the predominant income source throughout the island's recent history. One of the prominent factors in support of this development program has been the availability, thru PRWRA, of an adequate supply of electric power at reasonable cost. PRWRA's rates for electricity are comparable with those of electric utilities serving the Atlantic seaboard

of the U. S. They lie roughly in the middle of the range of these schedules between the high and low extremes. PRWRA is now the second largest non-Federal publicly-owned electric system in the United States and its territories.

The Khuzestan Region of Iran

(41) In southwestern Iran, bordering the head of the Persian Gulf, lies the region known as Khuzestan. It comprises an area of about 58,000 square miles, with a population of about 2-1/2 million. It includes a broad desert plain, very flat, extending from the Gulf to the Zagros or Bakhtiari Mountains to the north and east. In the foothills of these mountains lie most of the producing oil fields of Iran.

(42) The plain is drained by five rivers. On one of these, the Dez, there is rising toward early completion a thin arch concrete dam, sixth highest in the world, which will have initial generating capacity, in two units, of 130,000 kw, and ultimately an eight-unit capacity of 520,000 kw. It will be placed in operation in early 1963.

(43) In 1956, a U.S. private firm was asked by the Government of Iran to assist in devising a plan for the economic development of Khuzestan, the region which, for many centuries, was the source of the economic power of ancient Persia. After receiving and approving the recommendations, the Government asked the firm to assume responsibility for helping to execute them. The firm completed and delivered to Plan Organization a unified program for development of Khuzestan. This program included a total of some 6 million kilowatts of hydroelectric capacity in fourteen projects, and water supply for a million hectares of agricultural land.

(44) In 1957-58, electric power supply in Khuzestan was primitive. The only partial exception was Abadan, where the oil companies have one of the largest of the world's refineries. There the companies were supplying their own employees, which constitute the majority of the electricity consumers of the town. In the other urban centers, there were various combinations of public and private systems, with no control or regulation. Service was unreliable and otherwise inadequate, connection charges were exhorbitant, and rates were not such as to encourage the use of the service.

(45) As part of the development program, in 1959, a 132-kv transmission line was placed in service between Abadan and Ahwaz, the capital of Khuzestan province. This was used to deliver to Ahwaz power purchased from the oil companies at Abadan. The Ahwaz distribution system was rehabilitated and expanded. The number of consumers served has grown from 7,000 in 1958 to 18,000 in June, 1962. Included in the Ahwaz service area are about ten surrounding villages previously without electric service of any kind. Power demand on the Ahwaz system quadrupled in three years.

(46) As a basis for system rehabilitation and expansion in Ahwaz, D&R for the Government acquired the privately-owned system in the town and integrated it with the municipal system under the ownership of the newly-formed company owned by the municipality. D&R is assisting the Government in managing the affairs of this company and training its organization. A wholesale power contract which establishes retail rates and terms of sale was made effective. A similar series of steps is in progress in the four other urban centers of Khuzestan to which Dez power will initially be made available.

(47) As part of the plan, in 1960, the Government established the Khuzestan Water and Power Authority to carry on the development program, KWPA has its own legislative charter, which places primary responsibility for its affairs upon the Deputy Prime Minister and Head of the Government's Plan Organization. The Deputy Prime Minister can delegate his powers to the Managing Director of KWPA whom he also recommends for appointment by the Prime Minister. Such a delegation has been made. KWPA, under its charter, may use its revenues to finance its operations, may appoint its own officers and employees and fix the levels of their compensation. It establishes rates for the sale of electricity and charges for irrigation water. It maintains its own system of accounts, and, while wholly-owned by the Government, it is intended to have sufficient autonomy to operate as an independent enterprise.

KWPA is to conduct development operations for irrigation and power associated with the waters of the five Khuzestan rivers.

(48) KWPA has accepted full responsibility for power operations and for general services. In power operations, the Hydroelectric Power Commission of Ontario helps to operate and maintain the Dez hydroelectric project and to train a staff of Iranians later to assume these responsibilities. The Ontario Hydro group serves as part of the organization of KWPA's Power Division, which is headed by an Iranian engineer. Reporting to him is the Technical Director of the Power Division, through whom the various elements of the organization now report. By 1965, it is anticipated that the power operations of KWPA can be entirely handled by its Iranian organization, with the training it will have received.

(49) The Government of Iran negotiated with the International Bank for Reconstruction and Development, which agreed to lend $42 million to Iran for the Khuzestan program. The balance of the funds required are being supplied by Plan Organization, from Iran's oil revenues. The total cost of the present KWPA program is estimated at $150 million. Included are Dez Dam, transmission lines and substations, a pilot irrigation project, a sugar cane plantation and factory, and rehabilitation and expansion of five electric distribution systems in and near the principal load centers. The loan agreement with IBRD includes provisions for maintenance of rate levels for power and the establishment of KWPA.

(50) With the availability, for the first time, of modern reliable electric service, in adequate supply and at reasonable cost, power requirements in Khuzestan have been demonstrated to be capable of rapid growth. The third Dez generating unit is scheduled for installation in 1965-66, and will be needed by then. The fourth is scheduled for 1968. Its actual date of installation can be adjusted to meet any changes from the rate of growth of power needs which is now foreseen.

CONCLUSIONS

(51) Securing modern electric power supply for a particular less-developed area requires the solution of many problems which are peculiar to that area. The technical nature of the facilities to be provided, the type of primary energy sources which are available, the existing power systems and their integration, these and more need to be approached for each such area so that their solutions can be tailored to meet the area's needs. In the five cases which have been reviewed, however, there were some problems of significance for the solution of which common avenues were pursued. These common avenues may be of special interest as holding promise for other less-developed areas. These problems and their solutions were as follows.

(52) The problem: To establish an agency with power to exercise sufficient responsibility to carry out the necessary work. No private agency has accomplished this, and no existing agency of Government is set up with the necessary skills and authority. The solution: By formal governmental action, usually including actual legislation, to establish key policies and new institutions, separate from the regular administrative departments, although by various methods, responsible to and through the existing structure of Government at some fixed point. There are some especially significant policies for these institutions which appear with frequency:

(a) They resemble the corporate rather than the governmental form.
(b) They are intended to be largely autonomous.
(c) They are to have wide flexibility of action and decision.
(d) They are to be largely independent of the regular civil service.
(e) Accountability is assured by prescription of modern accounting practices and regular reporting.
(f) Administration and personnel are intended to be non-political.
(g) They are intended to be financially self-supporting, and to charge the users of their services enough to cover their costs.

(h) They are to be non-profit.

(i) They are to be exempt from regular taxation, with provision in some cases for payments in lieu of taxes under a specified formula. Except for such payments, none of the agencies can serve as a channel for contributions by electric consumers to the general funds of the owning government.

(53) The problem: To finance the cost of construction of the modern electricity supply facilities. The solution: With initial contributions from the sponsor or owning Government of cash and property, the new institution finances its costs through (a) its income, (b) its own internal and external borrowings, and (c) through borrowing made or guaranteed by the sponsor Government. In each case, the sponsor Government is in the position of the owner of the equity in the new institution, the new institution being responsible directly or indirectly for defraying the debt service costs. The return on the owner's equity is not ordinarily to be in cash terms, but in terms of benefit to the general welfare.

(54) The problem: How can the necessary higher skills be acquired rapidly in order to utilize and apply the advanced technologies involved in providing and operating a modern electric power system? The solution: Each case, in its own way, has involved the importation into a geographical area of management, engineering, and labor skills not indigenous to the area. Training programs are then depended upon to bridge the gap between (a) the early organization using foreign skills and (b) the ultimate organization made up largely of local people. Continuing availability of high-level technical and management assistance is obtained through appropriate contractual arrangements.

(55) The problem: How to integrate existing electric systems into the newly constructed system in such a way as to make optimum use of existing properties and organizations, while moving ahead toward the integrated system with its inherent economies. The solution: Most common among the five cases has been the negotiated purchase of existing privately-owned systems, and the absorption of existing publicly-owned systems, if any, into the new one. Existing organizations are absorbed, to the extent that they can be useful to the new institution, either directly or by re-training. Wholesale power contracts are also used as the vehicles through which the new institution's policies are adopted by local agencies distributing power supplied from the new system. They control retail rates and customer service and accounting policies. This is, of course, not necessary in cases such as PPC and PRWRA, which serve all, or practically all, ultimate consumers in their service areas.

(56) The problem: How to develop internal and external sources of financing for the large investments necessary to supplement its own and its owning Government's resources to provide for a modern electricity supply system? The solution: In each case the new institution has the power to borrow money in its own name, and has used this power or the borrowing power of its owning Government to secure a portion of the funds required. In each case, also, the new institution has the right to dispose of its revenues for power purposes. The electric power business can be depended upon to yield revenues adequate to cover its costs. Investors will be willing to advance funds for it at reasonable cost if they are assured that the institutional arrangements will preserve the financial integrity of the business; if, in other words, the credit of the new institution is established and maintained, if it is proven as a "good risk". The private capital markets, within the country or in the outside world are depended upon in some of the cases, others have so far limited themselves to public agencies, still others have used a combination of private and public sources. Supplier credits have also been utilized.

(57) The problem: How can the magnitude of future requirements be measured, in order to determine goals for the development of the new electric system? The solution: The records of actual growth for the five cases throw some light on this question. In each case there was a clean break from past records, when the institutions went into operation. With new objectives as to adequacy of electricity supply, levels of rates, etc., the increases in level of use were far greater than many expected. The most important step was the establishment and implementation of the new objectives. Then, the provision of new capacity to meet changing future needs could be geared to provide adequate margins. If

growth is less rapid than expected, planned expansion can be postponed, if growth is more rapid new facilities can be accelerated. Plans should be made for power system development which are geared to probable future levels of needs with certain specified timing assumptions. Changes of timing can then readily be accomplished as the facts of future requirements and their rates of growth become available. Initial market predictions can take into consideration basic economic considerations such as population and its growth, and specific industrial development possibilities, as well as experience in other areas when adequate power supply becomes available. The experience in the five cases shows that high rates of growth are probable, and that doubling every five years or so can be maintained for extended periods.

(58) The problem: Determining what role in electric power supply should be played by indigenous primary energy sources. The solution: Emphasis was first placed in all cases upon development of indigenous energy sources, especially water power. Then, as requirements continue to increase, local coal and oil refinery product resources enter the energy supply for the power system. Foreign exchange needs for oil purchases place a premium on the use of other primary sources which may encourage their development, even at somewhat higher economic cost. However, the premium thus paid by consumers of electricity as their contribution toward preserving their nation's foreign exchange balances should be continuously examined with a critical eye to assure that it does not become so large as to interfere with the accomplishment of the objectives of power system development. Electricity is a highly flexible form of energy. Technology now has advanced to the point that it can be produced economically through the use of a wide range of primary sources, including, in addition to water power, coal of practically all grades, natural gas, and many grades of petroleum products, ranging from crude oil, through light products to residual fuel oil (Bunker C) and even to refinery pitch which is used by PRWRA directly from the refinery and which is quite economical.

(59) With the establishment of public sources of financing such as the IBRD and its affiliates, International Finance Corporation and International Development Agency, the Inter-American Development Bank, the U. S. Agency for International Development and its counterparts among other Western nations, opportunities have greatly multiplied for less developed areas to secure assistance in financing modern electric power systems. Consulting and advisory services are widely offered by private and public agencies. And experience in other areas such as the five cases described here is accumulating rapidly.

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